SYMPOSIUM ON STOCHASTIC CONTROL AND NONLINEAR FILTERING

Crowne Plaza Hotel and University of Southern California
Los Angeles, California
December 13-15, 1997

The Symposium is organized in conjunction with the 36th Conference on Decision and Control to be held December 10-12, 1997 in San Diego, California. Updated information for the CDC conference will be made available on the conference's web page: http://master.ceat.okstate.edu/conference/cdc/cdc97.html. Complete information on the Symposium is available on the University of Southern California web page: http://www.usc.edu/dept/LAS/CAMS/conference/index.html

WELCOME AND ACKNOWLEDGMENTS

On behalf of the Program and Organizing Committees, we heartily welcome you to the Symposium on Stochastic Control and Nonlinear Filtering in Los Angeles, California. We hope that this is a very productive and enjoyable meeting for all of us. We welcome students and postdocs. We hope that it will be a great opportunity for you to learn and meet more senior stochastic people. Thanks to all of you for accepting our invitation and thank you for coming. Please note that we have representation from 11 different countries: Australia, Russia, Mexico, Poland, France, Germany, Hong Kong, Japan, U. S. A., Canada and Great Britain.

We are grateful to all who made this event happen. First of all thanks to our sponsors for their generous support and trust in the quality of our meeting: National Science Foundation, The Institute for Mathematics and Its Applications, Office of Naval Research and the University of Southern California.

Thanks to the Program Committee. Thanks to Tyrone Flournoy, Alexander Tartakovsky, Gloria Prothe, Kerrie Brecheisen and Sharon Gumm for their generous assistance and help.

With our very best wishes to you,
Bozenna Pasik-Duncan and
Boris Rozovskii

PROGRAM SPONSORS

National Science Foundation
The Institute for Mathematics and Its Applications

Office of Naval Research
University of Southern California

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	02/18/98	FINAL TECHNICAL (11/01/97 to 2/28/98)

4. TITLE AND SUBTITLE

Symposium on Stochastic Control and Nonlinear Filtering

5. FUNDING NUMBERS

N00014-98-1-0001

6. AUTHOR(S)

Boris Rozovsky

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)

University of Southern California
Center for Applied Mathematical Sciences
1042 W. 36th Pl. DRB 155
Los Angeles, California 90089-1113

8. PERFORMING ORGANIZATION REPORT NUMBER

N/A

9. SPONSORING / MONITORING AGENCY NAMES(S) AND ADDRESS(ES)

ONR, Mngmnt Off.: John Starcher, Program Off.: Julia Abrahams
Office of Naval Research
Regional Office San Diego
4520 Executive Drive Suite 300
San Diego, CA 92121-3019

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

N/A

a. DISTRIBUTION / AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE

12. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

An International Symposium on Stochastic Control and Nonlinear Filtering was held on December 13-15 at USC. The Symposium was organized and sponsored by the Center for Applied Math Sciences. The list of sponsors also includes: National Science Foundation, the Institute for Mathematics and Its Applications, and the Office of Naval Research. Seventy scientists from 11 countries (Australia, Russia, Mexico, Poland, France, Germany, Hong Kong, Japan, U. S. A., Canada and Great Britain) took part in the Symposium. This three-day event brought together a group of leading scholars in the fields of Stochastic Control and Nonlinear Filtering to discuss a variety of issues, including risk-sensitive control, adaptive control, stochastic partial differential equations and their applications to financial mathematics. The recent Nobel Prize in Economics awarded to Robert Merton and Myron Scholes brought substantial attention to applications of stochastic analysis to finance and economics. An important feature of the conference was participation of a large group of students. Some of them presented interesting papers on their research. It was a good opportunity for all participants to network, to discuss future directions of research and teaching.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Nonlinear Filtering, Stochastic Theory, Stochastic Control, Finacial Applications, Stochastic PDE's, Estimation.	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

PROGRAM FOCUS

This three-day event is meant to gather a group of leading scholars in the fields of Stochastic Control and Nonlinear Filtering to discuss leading-edge stochastic control and nonlinear filtering research, which includes risk-sensitive control, adaptive control, estimation, identification, optimal control, nonlinear filtering, stochastic differential equations and stochastic partial differential equations with their computational aspects, stochastic theory and its applications. The recent Nobel Prize in Economics went to Robert Merton and Myron Scholes and this brings nice recognition to Stochastic Theory and its Applications. The slate of invited speakers will have the opportunity to discuss the way in which branches of stochastic theory influences their research. Speakers were strongly encouraged to make their talks as accessible as possible to the wide variety of stochastic participants which will include students. Finally, it will be an opportunity for all of us to network and discuss cutting-edge technologies and applications, teaching and future directions of stochastic control.

PROGRAM COMMITTEE

W. Fleming, Brown University; E. Pardoux, Universite de Provence, France; A. Bensoussan, CNES, Paris, France; A. Shirayev, Moscow State University, Russia; J. Zabczyk, Institute of Mathematics, Polish Academy of Sciences, Poland; N. Krylov, University of Minnesota; G. Kallianpur, University of North Carolina, Chapel Hill; R. Khasminskii, Wayne State University; G. DaPrato, Scuola Normale Superiore de Pisa, Italy; T. Duncan, University of Kansas; H. Kushner, Brown University; P. Varaiya, University of California, Berkeley.

ORGANIZERS

Bozenna Pasik-Duncan, University of Kansas, Lawrence, Kansas
Boris Rozovskii, University of Southern California, Los Angeles, California

LOCATION

Crowne Plaza Hotel
3540 South Figueroa St.
Los Angeles, CA
213-748-4141

Center for Applied Mathematical Sciences
Department of Mathematics
Denney Research Bldg. 155
University of Southern California
Los Angeles, CA 90089-1113
213-740-2395

The sessions will be held in rooms 224 (Mary Pickford room) and 305 of the Andrus Gerontology Center (3715 McClintock Ave.) at the University of Southern California.

CLIMATE

Extremely pleasant, temperature around 60 F. Sometimes warmer, sometimes cooler.

KEYNOTE SPEAKERS

W. Fleming, Brown University
R. Khasminskii, Wayne State University

SPEAKERS AND PARTICIPANTS

John Baras, *Combined Estimation and Control of HMMs*
Bernard Bercu, *Asymptotic Results for Least Squares Algorithms in Adaptive Tracking*
Tomasz Bielecki, *Risk-Sensitive Control Methods and Factor Modeling in Mathematical Finance*
Michelle BouÈ, *Risk-Sensitive and Robust Escape Control for Degenerate Processes*
Pierre Del Moral, *Large Deviation Principles for Interacting. Particle Systems. Application to Nonlinear Filtering Problem*
Tyrone Duncan, *Ergodic Control and Filtering for Stochastic Semilinear Systems with Boundary Processes*
Robert Elliott, *Filtering Commodity Prices*
Guillermo Ferreyra, *Pathwise Comparison of Solutions of SDEs*
Wendell Fleming, *Optimal Long-term Growth Rate of Expected Utility of Wealth*
Ulrich Haussmann, *A Singular Stochastic Control Problem*
Kurt Helmes, *Computing Moments of Exit Times of Markov Processes by Linear Programming*
Daniel Hernandez-Hernandez, *Risk Sensitive Control of Markov Processes*
Yaozhong Hu, *Finite Difference Schemes of a Class of SPDE*
Kazufumi Ito, *Nonlinear Filtering Algorithms*
Matthew James, *Robustness of Risk-Sensitive Filtering and Control*
Simon Julier, *Extensions to the Unscented Transformation*
Ioannis Karatzas, *Adaptive Control of a Diffusion to a Goal, and a Parabolic Monge-AmpËre-Type Equation*
Rafail Khasminskii, *Estimation of Source for Linear PDE*
Tze Lai, *Optimal Stopping, Generalized Ito's Formula and the Pricing of American Options*
Francois LeGland, *Small Noise Asymptotics of Nonlinear Filters with Nonobservable Limiting Deterministic System*
Sergey Lototsky, *Spectral Asymptotics of Some Functionals Arising in Statistical Inference for SPDEs*
Dora Matache and Peter Zimmer, *Analysis and Modeling of ATM Traffic from Sprint Network*
William McEneaney, *Max-Plus Methods in Nonlinear Robust Filtering*
Hideo Nagai, *Singular Limits of Bellman-Isaacs Equations of Ergodic Type Related to Risk-Sensitive Control*
Alexander Nazin, *Information Approach to Adaptive Control of Discrete Stochastic Systems*
Daniel Ocone, *Asymptotic Stability of Filters*
Bozenna Pasik-Duncan, *Continuous-Time Stochastic Adaptive Control*
Agnieszka Plucinska, *Some Properties of Hermite Polynomials with Random Arguments*
Alex Poznyak, *Information Inequalities in Adaptive Stochastic Control*
Kavita Ramanan, *Some New Results on the Skorokhod Problems*
C. Rao, *Some New Numerical Schemes for Nonlinear Filtering*
Raymond Rishel, *Optimal Portfolio Management with Partial Observations*
Boris Rozovskii, *Splitting-Up Discretization for Kushner's Equation*
Isaac Sonin, *The Elimination Algorithm in Optimal Stopping Problems*
James Spall, *Gaussian-Based Filtering in a Non-Gaussian World: What Can We Say?*
S. S. Sritharan, *Optimal Control of Stochastic Navier-Stokes with Linear and Monotone Viscosities*
Srdjan Stojanovic, *Optimal Diversification Under Constraints: Monge-AmpËre Equations and Computations*
Michael Taksar, *Continuous Time Optimal Control Models in Insurance*
Stephen Yau, *Recent Advance in Brockett-Mitter Program on Nonlinear Filtering*
George Yin, *On Global Stochastic Optimization Algorithms*
Omar Zane, *Valuing Moving Barrier Options*
Aleksandar Zatezalo, *Filtering of Finite-State Time-Nonhomogenious Markov Processes, a Direct Approach*
Qing Zhang, *Nonlinear Filtering and Control of a Hybrid System*
X. Y. Zhou, *How Costly is Uncertainty?*

Ai-Jun Gao
Chunli Hou
Andrius Jankunas
Thomas Little
Ruihua Liu
Jesus Pascal
Wendy Poston
Adam Szpiro
Jeff Uhlman
Pirooz Vakili
Ananda Weerasinghe
Xiaoliang Zhao

SOCIAL EVENTS

Saturday:	10:00-11:00	Coffee Reception
Sunday:	4:15-10:00	Marina del Rey, 4 hour dinner cruise aboard *El Presidente*
Monday	6:00	Closing Reception

Contact:

Bozenna Pasik-Duncan
Dept. of Mathematics
University of Kansas
Lawrence, KS 66045
tel. 785-864-3651
bozenna@kuhub.cc.ukans.edu

Local contact:

Tyrone Flournoy
Center for Applied Mathematical Sciences
University of Southern California
DRB 308 MC1113
Los Angeles, CA 90089-1113
tel. 213-740-2395
flourny@cams.edu.usc

Alexander Tartakovsky
Center for Applied Mathematics
University of Southern California
DRB 326 MC1113
Los Angeles, CA 90089-1113
tel. 213-740-2450
tartakov@cams.usc.edu

PROGRAM

SATURDAY, DECEMBER 13

10:00-11:00 **Coffee Reception**

1:00 Welcome and Opening Remarks
B. Rozovskii, University of Southern California

1:00-2:00 *Estimation of Source for Linear PDE*
R. Khasminskii, Wayne State University
Chair: B. Rozovskii, University of Southern California

2:00-4:00 SESSION I: Stochastic Control and Nonlinear Filtering
Chair: R. Khasminskii, Wayne State University

2:00-2:30 I. Karatzas, *Adaptive Control of a Diffusion to a Goal, and a Parabolic Monge-AmpËre-Type Equation*

2:30-3:00 H. Nagai, *Singular Limits of Bellman-Isaacs Equations of Ergodic Type Related to Risk-Sensitive Control*

3:00-3:30 B. Rozovskii, *Splitting-Up Discretization for Kushner's Equation*
(joint work with K. Ito)

3:30-4:00 R. Elliott, *Filtering Commodity Prices*

4:00-4:15 **Tea Break**

4:15-6:15 SESSIONS II and III

Session II: Nonlinear Filtering
Chair: M. James, Australian National University

4:15-4:45 F. LeGland, *Small Noise Asymptotics of Nonlinear Filters with Nonobservable Limiting Deterministic System*

4:45-5:15 S. Yau, *Recent Advance in Brockett-Mitter Program on Nonlinear Filtering*

5:15-5:45 K. Ito, *Nonlinear Filtering Algorithms*

5:45-6:15 S. Lototsky, *Spectral Asymptotics of Some Functionals Arising in Statistical Inference for SPDEs* (joint work with B. Rozovskii)

Session III: Stochastic Theory and Control
Chair: K. Helmes, University of Kentucky

4:15-4:45 G. Ferreyra, *Pathwise Comparison of Solutions of SDEs* (joint work with P. Saundar)

4:45-5:15 B. Bercu, *Asymptotic Results for Least Squares Algorithms in Adaptive Tracking*

5:15-5:45 A. Poznyak, *Information Inequalities in Adaptive Stochastic Control*

5:45-6:15 A. Plucinska, *Some Properties of Hermite Polynomials with Random Arguments*

SUNDAY, DECEMBER 14

8:30-10:30 **SESSION IV: Stochastic Control and Nonlinear Filtering**
Chair: J. Baras, University of Maryland

8:30-9:00 R. Rishel, *Optimal Portfolio Management with Partial Observations*

9:00-9:30 U. Haussmann, *A Singular Stochastic Control Problem*

9:30-10:00 M. James, *Robustness of Risk-Sensitive Filtering and Control*

10:00-10:30 W. McEneaney, *Max-Plus Methods in Nonlinear Robust Filtering*
(joint work with W. H. Fleming)

10:30-10:45 **Coffee Break**

10:45-11:45 *Optimal Long-Term Growth Rate of Expected Utility of Wealth*
W. Fleming, Brown University
Chair: G. Yin, Wayne State University

11:45-1:00 **Lunch Break**

1:00-2:00 **SESSION V: Stochastic Control and Nonlinear Filtering**
Chair: U. Haussmann, University of British Columbia

1:00-1:30 X. Zhou, *How Costly is Uncertainty?*

1:30-2:00 Q. Zhang, *Nonlinear Filtering and Control of a Hybrid System*

2:00-2:15 **Tea Break**

2:15-4:15 **SESSIONS VI and VII**

Session VI: Stochastic Theory and Finance
Chair: I Karatzas, Columbia University

2:15-2:45 T. Lai, *Optimal Stopping, Generalized Ito's Formula and the Pricing of American Options*

2:45-3:15 M. Taksar, *Continuous Time Optimal Control Models in Insurance*

3:15-3:45 T. Bielecki, *Risk-Sensitive Control Methods and Factor Modeling in Mathematical Finance*

3:45-4:15 O. Zane, *Valuing Moving Barrier Options* (joint work with L. C. G. Rogers)

4:15-10:00 **Conference Reception on board *El Presidente* (4 hour dinner cruise)**

Session VII: Stochastic Theory and Nonlinear Filtering
Chair: M. BouÈ, University of Massachusetts

2:15-2:45 K. Ramanan, *Some New Results on the Skorokhod Problems* (joint work with P. Dupuis)

2:45-3:15 P. Del Moral, *Large Deviation Principles for Interacting. Particle Systems. Application to Nonlinear Filtering Problem*

3:15-3:45 S. Julier, *Extensions to the Unscented Transformation*

3:45-4:15 A. Zatezalo, *Filtering of Finite-State Time-Nonhomogenious Markov Processes, a Direct Approach* (joint work with N. V. Krylov)

MONDAY, DECEMBER 15

8:30-10:30 **SESSION VIII: Stochastic Control and Nonlinear Filtering**
Chair: T. Duncan, University of Kansas

8:30-9:00 J. Baras, *Combined Estimation and Control of HMMs*

9:00-9:30 D. Ocone, *Asymptotic Stability of Filters*

9:30-10:00 D. Hernandez-Hernandez, *Risk Sensitive Control of Markov Processes*

10:00-10:30 K. Helmes, *Computing Moments of Exit Times of Markov Processes by Linear Programming*

10:30-10:45 **Coffee Break**

10:45-12:15 **SESSION IX: Stochastic Optimization and Filtering**
Chair: R. Rishel, University of Kentucky

10:45-11:15 T. Duncan, *Ergodic Control and Filtering for Stochastic Semilinear Systems with Boundary Processes*

11:15-11:45 G. Yin, *On Global Stochastic Optimization Algorithms*

11:45-12:15 J. Spall, *Gaussian-Based Filtering in a Non-Gaussian World: What Can We Say?*

12:15-2:00 Lunch Break

2:00-4:30 **SESSIONS X AND XI**

Session X: Stochastic Theory and Adaptive Control
Chair: A. Plucinska, Warsaw Technical University

2:00-2:30 I. Sonin, *The Elimination Algorithm in Optimal Stopping Problems*

2:30-3:00 A. Nazin, *Information Approach to Adaptive Control of Discrete Stochastic Systems* (joint work with A. Juditsky)

3:00-3:30 B. Pasik-Duncan, *Continuous-Time Stochastic Adaptive Control* (joint work with T. Duncan and L. Guo)

3:30-4:00 D. Matache and P. Zimmer, *Analysis and Modeling of ATM Traffic from Sprint Network* (joint work with T. Duncan and B. Pasik-Duncan)

Session XI: Stochastic Control and Nonlinear Filtering
Chair K. Ramanan, Bell Labs, Lucent Technologies

2:00-2:30 M. BouÈ, *Risk-Sensitive and Robust Escape Control for Degenerate Processes* (joint work with P. Dupuis)

2:30-3:00 Y. Hu, *Finite Difference Schemes of a Class of SPDE*

3:00-3:30 S. S. Sritharan, *Optimal Control of Stochastic Navier-Stokes with Linear and Monotone Viscosities*

3:30-4:00 S. Stojanovic, *Optimal Diversification Under Constraints: Monge-AmpËre Equations and Computations*

4:00-4:30 C. Rao, *Some New Numerical Schemes for Nonlinear Filterings* (joint work with B. Rozovskii)

4:30-4:45 Tea Break

4:45-6:00 **SUMMARY SESSION**

Part I, Future Directions of Stochastic Control and Nonlinear Filtering
Part II, Stochastic Control Education

Panelists include invited speakers, students, and post docs.

Moderators: W. Fleming and B. Pasik-Duncan

6:00- Closing Remarks: B. Rozovskii

Closing Reception

ABSTRACTS

The abstracts are ordered alphabetically according to the last name of the speaker.

Name: John Baras, University of Maryland

Title: *Combined Estimation and Control of HMMs*

Program Abstract: The principal contribution of this paper is the presentation of the potential theoretical results that are needed for an application of stochastic approximation theory to the problem of demonstrating asymptotic stability for combined estimation and control of a plant described by a hidden Markov model. We motivate the results by briefly describing a combined estimation and control problem. We show how the problem translates to the stochastic approximation framework. We also show how the Markov chain that underlies the stochastic approximation problem can be decomposed into factors with discrete and continuous range. Finally, we use this decomposition to develop the results that are needed for an application of the ODE method to the stochastic control problem.

Name: Bernard Bercu, University of Paris-Sud.

Title: *Asymptotic Results for Least Squares Algorithms in Adaptive Tracking*

Program Abstract: In ARMAX adaptive tracking, we show that the WLS algorithm performs as well as the ELS for parameter estimation. In AR adaptive tracking, we prove that the LS and the WLS algorithms share the same CLT and LIL. We finally answer the natural question: What is the interest in using the WLS algorithm?

Name: Tomasz R. Bielecki, Northeastern Illinois University

Title: *Risk-Sensitive Control Methods and Factor Modeling in Mathematical Finance*

Program Abstract: An important problem in finance is the problem of optimal investment management. Several versions of this problem will be formulated in terms of risk-sensitive stochastic optimal control and factor modeling of essential financial market parameters. In particular, the risk-sensitive optimal portfolio selection problem in the presence of general transaction costs will be formulated as a risk-sensitive stochastic impulsive control problem and an approach to its solution will be discussed. In the case of absence (insignificance) of transaction costs, the optimal risk-sensitive stochastic control problem. A complete solution to a version of this problem will be presented, as well as some recent empirical results.

Name: Michelle BouÈ, University of Massachusetts-Amherst

Title: *Risk-Sensitive and Robust Escape Control for Degenerate Processes*
(work in collaboration with P. Dupuis)

Program Abstract: We consider the problem of controlling a degenerate small noise diffusion so as to prevent it from leaving a prescribed set. The criterion of interest is a risk-sensitive version of the mean escape time criterion. It is shown that in the small noise limit, the value of this criterion converges to the value of a deterministic differential game. The result provides a canonical example of the use of variational representations in connecting risk-sensitive and robust control.

Name: Pierre Del Moral, University Paul Sabatier

Title: *Large Deviation Principles for Interacting Particle Systems. Applications to Non-Linear Filtering Problems*

Program Abstract: The non-linear filtering problem consists in computing the conditional distributions of a Markov signal process given its noisy observations. The dynamics structure of such distributions can be modeled by a measure valued dynamical Markov process. Several random particle approximations were recently suggested to approximate recursively, in time, the so-called non-linear filtering equations.

The aim of this talk is the design of an interacting and branching particle system approach for the computation of some discrete time and measure valued dynamical systems arising in engineering and, particularly, in non-linear filtering. We will also present some large deviations principles for the empirical measures of the particle systems.

Name: Tyrone E. Duncan, University of Kansas

Title: *Ergodic Control and Filtering for Stochastic Semilinear Systems with Boundary Processes*

Program Abstract: An ergodic control problem is formulated and solved where the control occurs only on the boundary or at discrete points in the domain. The existence and the uniqueness of the invariant measures and the existence of an optimal control are given. The continuity of the invariant measures and the optimal cost with respect to parameters are verified. A filtering problem is formulated where the signal process is on the boundary or at discrete points.

Name: Robert J. Elliott, University of Alberta

Title: *Filtering Commodity Prices*

Program Abstract: Recent work by Eduardo Schwartz models the price of a commodity such as oil or copper in terms of the spot price and convenience yield. The convenience yield represents the value of holding amounts of the commodity and is analogous to the interest rate, however, neither the spot price nor convenience yield are observed directly. Linearized equations are considered and the futures prices taken as observables. Extensions of the filters of Elliott and Krishnamurthy are used to calibrate the model.

Name: Guillermo Ferreyra, Louisiana State University

Title: *Pathwise Comparison of Solutions of SDEs* (work in collaboration with P. Sundar)

Program Abstract: A pathwise comparison theorem for solutions of one dimensional SDEs with different dispersion and drift coefficients is presented. Applications include models for price evolution of options with stochastic volatility. Also, a pathwise comparison theorem for stochastic Volterra equations driven by continuous semimartingales is presented.

Name: Wendell Fleming, Brown University

Title: *Optimal Long-Term Growth Rate of Expected Utility of Wealth*
(work in collaboration with S.-J. Sheu)

Program Abstract: An optimal investment policy model is considered in which the goal is to maximize the long-term growth rate of expected utility of wealth. Following Platen-Rebolledo, logarithms of stock prices are subject to Ornstein-Uhlenbeck type random fluctuations about a deterministic trend. A HARA utility function is used. This problem is reduced to one of infinite horizon risk-sensitive control, with expected exponential-of-integral criterion.

Name: Ulrich Haussmann, University of British Columbia

Title: *A Singular Stochastic Control Problem*

Program Abstract: A singular stochastic control problem which arises in mathematical economics is solved. An associated problem which has the same free boundary is found. This boundary is shown to be smooth. That fact allows the construction of the optimal control and of the optimal state process—a reflected diffusion.

Name: Kurt Helmes, University of Kentucky

Title: *Computing Moments of Exit Times of Markov Processes by Linear Programming*

Program Abstract: We provide an approach to the numerical computation of moments of exit times of the Markov processes. The method relies on a linear programming formulation of a process exiting from a bounded domain. The LP formulation characterizes the evolution of the stopped process through the moments of the induced occupation measure. Excellent software is readily available since the computations involve finite dimensional linear programs.

Name: Daniel Hernandez-Hernandez, CINVESTAV del IPN

Title: *Risk-Sensitive Control of Markov Process*

Program Abstract: In this discussion, we shall be concerned with the existence of optimal stationary policies for infinite horizon risk-sensitive Markov control processes with denumerable state space and long-term average cost.

Name: Yaozhong Hu, University of Kansas

Title: *Finite Difference Schemes of a Class of SPDE*

Program Abstract: We prove the convergence of finite difference schemes to a class of stochastic pressure equation, i.e., a stochastic elliptic-type partial differential equation with Dirichlet condition.

Name: Kazi Ito, North Carolina State University

Title: *Non-linear Filtering Algorithms*

Program Abstract: In this session, we discuss the filtering algorithms based on Zakai and Kushner and Robust and Bayes formulae. Efficient numerical integrations and convergence analysis of the filtering algorithms will be presented.

Name: Matthew James, Australian National University

Title: *Robustness of Risk-Sensitive Filtering and Control*

Program Abstract: This session will discuss an interpretation of the risk-sensitive cost criterion, which is relevant to the fundamental problem of robustness.

Name: Simon Julier, IDAK Industries

Title: *Extensions to the Unscented Transformation*

Program Abstract: The unscented transform calculates the statistics of a transformed probability distribution using a set of deterministically chosen points which capture certain aspects of the prior distribution. To date, this method has only been used to propagate the mean and covariance. In this discussion, a method of extending the unscented transform to capture higher order information such as skew and kurtosis is described. The benefits of this additional information will be examined in some simple tests.

Name: Ioannis Karatzas, Columbia University

Title: *Adaptive Control of a Diffusion to a Goal and a Parabolic Monge-AmpËre-Type Equation*

Program Abstract: We study the following adaptive stochastic control problem: to maximize the probability P[X(T) = 1] of reaching the "goal" x = 1 during the finite time-horizon [0,T], over "control" processes $\pi(\supseteq)$ which are adapted to the natural filtration of the "observation" process Y(t) = W(t) + Bt,

$0 \leq t \leq T$ and satisfy almost surely $\int_0^T \pi^2(t)dt <$ and $0 \leq X(t) = x + \int_0^t \pi(s)dY(s) \leq 1, \forall 0 \leq t \leq T.$

Here $W(\supseteq)$ is standard Brownian motion, and B is an independent random variable with known distribution μ. The case B + b 0 of this problem was studied by Kulldorff (1993). Modifying a martingale method due to Heath (1993), we find an optimal control process $\hat{\pi}(\supseteq)$ for the general case of this problem, and solve explicitly for its value and for the associated Hamilton-Jacobi-Bellman equation

of Dynamic Programming. This reduces to $2Q_{xx}Q_s = Q_{xx}Q_{yy} - Q_{xy}^2$,

an apparently novel parabolic-Monge-AmpËre-type equation.

Name: Rafail Khasminskii, Wayne State University

Title: *Estimation of Source of Linear PDE*

Program Abstract: The estimation problem for the source for linear PDE is considered in the assumption that the solution of the equation is observed in the additive Gaussian White Noise with small intensity ε. The estimators with the optimal rate of convergence to 0 risks for $\varepsilon \varnothing 0$ are found for the various a priori information on the smoothness of the source. The filtering type of estimators are also proposed.

Name: Tze L. Lai, Stanford University

Title: *Optimal Stopping, Generalized Ito's Formula and the Pricing of American Options*

Program Abstract: We first present some recent results on corrected random-walk approximations to continuous-time optimal stopping problems for Brownian motion and then apply these results to find accurate closed-form approximations for the valuation and exercise boundaries of American options. In connection with optimal stopping problems, generalization of Ito's formula to functions with generalized second derivatives is also discussed.

Name: Francois LeGland, IRISA/INRIA

Title: *Small Noise Asymptotics of Non-Linear Filters with Non-Observable Limiting Deterministic System* (work in collaboration with M. Joannides)

Program Abstract: We study the asymptotic behavior, as observation noise goes to zero, of the non-linear filter in a model where the state equation is noise-free and where the limiting deterministic system is non-observable. Using asymptotics of Laplace integrals, we give an explicit expression for the limit of the non-linear filter, and we study the rate of convergence. The results are applied to the problem of target tracking with bearings only measurements.

Name: Sergey Lototsky, M.I.T.

Title: *Spectral Asymptotics of Some Functionals Arising in Statistical Inference for SPDEs* (work in collaboration with B. L. Rozovskii)

Program Abstract: Asymptotic properties are studies of a projection-based estimate of an unknown parameter in a stochastic evolution equation on a compact smooth manifold. Under certain non-degeneracy assumptions, consistency, asymptotic normality, and moment convergence of the estimate are proved as the dimension of the projections' increases. Unlike previous works on the subject, no commutativity is assumed between the operations in the equation.

Name: Mihaela T. Matache and Peter Zimmer, University of Kansas

Title: *Analysis and Modeling of ATM Traffic from Sprint Network*

Program Abstract: The data that we were given covers ATM traffic for a 48-hour period. The Hurst parameter was estimated, cell counts per unit time were completed, and interarrival times were determined. Source modeling was completed for the two large VBR (variable bit rate) users and a CBR (constant bit rate) user from the data. The models were validated by estimating the Hurst parameters from these models and comparing these estimates to the estimates of Hurst parameters from the data. The interarrival times of the models and the data were also compared. Some analysis of the queues in the buffers was completed by computing the sample mean, variance, and maximum of the buffer usage. Quantiles were also determined. The source modeling provides a methodology for source modeling both for the VBR users and a CBR user.

Name: William M. McEneaney, North Carolina State University

Title: *Max-Plus Methods in Non-Linear Robust Filtering* (work in collaboration with W. H. Fleming)

Program Abstract: We consider the Robust Filtering problem. In the case of discrete-time measurements, the HJB equation describing propagation of the information state between measurements is a first-order equation containing a term which is quadratic in the gradient. Nevertheless, the corresponding solution operator is linear in the max-plus algebra (where "addition" is defined as maximization and "multiplication" is defined as addition). This leads, naturally, to numerical methods involving max-plus basis function representations of the solution.

Name: Hideo Nagai, Osaka University

Title: *Singular Limits of Bellman-Isaacs Equations of Ergodic-Type Related to Risk-Sensitive Control*

Program Abstract: We shall treat some specialized class of Bellman-Isaacs equations of ergodic-type arising from risk-sensitive control, in relation to eigenvalue problems of Schr^dinger operator. Their singular limits are known to be related to non-linear H infinity control, and the limit equations usually lack uniqueness of solutions. We shall focus our arguments on the limiting procedure and note that further analysis enables us to specify the limits as particular solutions of the equations.

Name: Daniel Ocone, Rutgers University

Title: *Asymptotic Stability of Filters*

Program Abstract: We say that a filter is asymptotically stable if the solution to the filtering equations when improperly initialized converge to the true conditional distribution in the infinite time limit. We survey some of the recent progress--relative entropy bounds, special cases, analysis of Zakai's equation--and open problems.

Name: Bozenna Pasik-Duncan, University of Kansas

Title: *Continuous-Time Stochastic Adaptive Control*

Program Abstract: The adaptive linear quadratic Gaussian control problem where the linear transformation of the state, A, and the linear transformation of the control, B, are unknown, is solved assuming only controllability and observability. A weighted least squares algorithm is modified by using a random regularization to ensure that the family of estimates is uniformly controllable and observable. A diminishing excitation is used with the adaptive control to ensure that the family of estimates is strongly consistent. The family of estimates also identifies parameters for deterministic systems. A lagged certainty equivalence control using this family of estimates is shown to be self-optimizing for an ergodic, quadratic cost functional.

Name: Agnieszka Plucinska, Warsaw Technical University

Title: *Some Properties of Hermite Polynomials with Random Arguments*

Program Abstract: The paper is divided into three sections:

I. Let X be an r.v. with a polynomial-Gaussian density (the product of a non-negative polynomial and a Gaussian density). The properties of Hermite polynomials in Gaussian r.v.'s and in Gaussian processes are well known. We give some properties of Hermite polynomials in X.

II. We present a probabilistic characterization of deterministic Hermite polynomials (by a martingale property) [1]

III. Remarks on applications of Hermite polynomials in Stochastic Control.

References

[1] A. Plucinska, "A Stochastic Characterization of Hermite Polynomials" Journal of Math Sciences, to appear in 1998.

Name: Alexander S. Poznyak, CINVESTAV - IPN

Title: *Information Inequalities in Adaptive Stochastic Control*

Program Abstract: We state the analytical expression for the maximum possible adaptation rates for the class of adaptation control strategies corresponding to the indirect adaptation approach which uses parallel identification procedures. These information bounds present the generalization of the Cramer-Rao Inequality to Adaptive Stochastic Control field. The tracking and regulations problems are considered in detail. To obtain the best adaptation rate, we have to use a recursive version of Maximum Likelihood estimators with non-linear residual transformation.

Name: Kavita Ramanan, Bell Labs, Lucent Technologies

Title: *Some New Results on the Skorokhod Problem* (work in collaboration with P. Dupuis)

Program Abstract: The Skorokhod Problem proves very convenient for analyzing constrained processes like, for example, stochastic differential equations, with reflection, and "fluid limits" of queueing networks, which have been found useful in designing controls for the networks.

We consider Skorokhod Problems that have polyhedral domains with a constant, possibly, oblique constraint direction on each face of the domain. We describe a new technique to establish regularity of the associated Skorokhod Maps and illustrate it with concrete applications that arise in communication networks.

Name: Raymond Rishel, University of Kentucky

Title: *Optimal Portfolio Management with Partial Observations*

Program Abstract: For a doubly stochastic model of stock prices, the optimal portfolio management policy is computed for the problem of investing for a fixed time and maximizing the expected terminal utility for the power utility function.

Name: Boris Rozovskii, USC

Title: *Splitting-up Discretization for Kushner's Equation*

Program Abstract: The overwhelming majority of numerical schemes for optimal nonlinear filtering of randomly perturbed dynamical systems deal with the Zakai equation. Unfortunately, in spite of its popularity, the Zakai equation has serious deficiencies as a computational tool. These include the following: (a) fast dissipation of the solution as the number of time steps grows, (b) the effect of intermittency which manifests itself in the appearance of rare but very large peaks. On the contrary, it appears that Kushner's equation of nonlinear filtering is not subject to the aforementioned problems. In this talk direct operator splitting-up approximations of the Kushner equation and their relation to the splitting-up approximation to the Zakai equation with normalization on each step will be discussed.

Name: Isaac Sonin, University of North Carolina at Charlotte

Title: *The Elimination Algorithm in Optimal Stopping Problem*

Program Abstract: We present a new algorithm for solving the optimal stopping problem, which can also be useful for recursively finding the various characteristics of Markov chain; for example, the distribution of a Markov chain at the moment of first exit from a given set. The algorithm is based on the idea of elimination of the states where stopping is non-optimal in the one step problem and the corresponding correction of transition probabilities.

Name: James Spall, The Johns Hopkins University

Title: *Gaussian-based Filtering in a Non-Gaussian World: What Can We Say*

Program Abstract: Despite the progress of the last two decades in non-linear/non-Gaussian filtering, one of the realities of practical problem solving is that the linear (Kalman) filter is often used in applications where it is known to not be the optimal estimator. There are good reasons why this is so and why it will continue to be so. This talk will summarize some recent results that allow one to make rigorous statements about the accuracy of the Kalman filter when the noise terms in the state-space model have unknown (non-Gaussian) distributions.

Name: S. S. Sritharan, U.S. Navy-San Diego

Title: *Optimal Control of Stochastic Navier-Stokes Equation With Linear and Monotone Viscosities*

Program Abstract: We will consider the task of finding optimal controls for stochastically forced fluid flow with linear and non-linear viscosities. Martingale problem formulation is used along with Minty-Browder technique to deal with the monotone viscosity term within the drift. Both Tonelli- as well as Young-(measure) type optimal controls are obtained. The abstract infinite dimensional stochastic model also covers other equations belonging to the "Navier-Stokes mathematical family" such as Boussinesq System for fluid-thermal flow, MHD equations for "plasma fusion" and "constant density combustion equations".

Name: Srdjan Stojanovic, University of Cincinnati

Title: *Optimal Diversification Under Constraints: Monge-AmpÈre Equations and Computations*

Program Abstract: The problem of maximizing the probability of reaching certain value of wealth by the given deadline is considered in the setting of optimal control for stochastic differential equations. The portfolio consists of an arbitrary number of stocks and a bank account. Multiple constraints on the portfolio are allowed. The corresponding value function is characterized as a suitable solution of an equation of (degenerate) Monge-AmpËre type. The equation is solved numerically by an efficient and stable algorithm, and computational experiments are presented.

Name: Michael I. Taksar, State University of New York at Stony Brook

Title: *Continuous Time Optimal Control Models in Insurance*

Program Abstract: We consider an insurance company whose reserve can be modeled by a diffusion process. The company distributes part of the reserve to its shareholders as dividends. It also has an option of reducing its risk by proportional reinsurance. When the reserve reaches zero, we consider the company broke and dissolved. The objective is to maximize the expected dividends payout until the time of bankruptcy.

We analyze several models with and without possibility of reinsurance. We will also look into the effects of the corporate debt on the optimal policy.

Name: Stephen S-T. Yau, University of Illinois at Chicago

Title: *Recent Advance in Brockett-Mitter Program on Non-Linear Filtering*

Program Abstract: Brockett-Mitter Program on non-linear filtering was proposed by Brockett and Mitter around 1970. The idea is to use Wei-Norman approach to construct finite dimensional filters. One has to complete several steps in order to carry out this program: 1) Classification of finite dimensional estimation algebra; 2) Solve DMZ equation by means of Kolmogorov equation and a system of ODE; and 3) Solve the Kolmogorov equation and the system of ODE.

Name: George Yin, Wayne State University

Title: *On Global Stochastic Optimization Algorithms*

Program Abstracts: We analyze global stochastic approximation algorithms. The focus is on convergence and rates of convergence. We also study algorithms with partial step-size restarting, which naturally lead to a diffusion process with diminishing noise intensity. In addition, applications to image segmentation will be mentioned.

Name: Omar Zane, First Chicago NBD

Title: *Valuing Moving Barrier Options* (work in collaboration with L. Chris G. Rogers)

Program Abstract: We will show how to compute prices of options knocked out when the underlying price crosses smoothly-moving barriers. The method is to reduce the problem to fixed barriers by transformation of the state space, and to change time so as to make the underlying diffusion into a Brownian motion with time-dependent drift.

Name: Aleksandar Zatezalo, University of Minnesota

Title: *Filtering of Finite-State Time-Nonhomogeneous Markov Processes, a Direct Approach* (work in collaboration with N. V. Krylov)

Program Abstract: Filtering equation is derived for $P(x_t = x \mid y_s, s \in [0,t])$ for a continuous-time finite-state two-component time-nonhomogeneous cadlag Markov processes $z_t = (x_t, y_t)$. The derivation is based on some new ideas in the filtering theory and does not require any knowledge of stochastic integration.

Name: Qing Zhang, University of Georgia

Title: *Non-linear Filtering and Control of a Hybrid System*

Program Abstract: This discussion is concerned with filtering and control of a switching diffusion coupled by an unknown Markov chain. Statistical estimation methods are used to track the unknown Markov chain. Computable approximate filters are obtained. The filters are then used to construct controls for the partially observed system. These controls are shown to be asymptotically optimal as the observation noise tends to zero. Finally, an example is considered and numerical experiments are reported.

Name: XunYu Zhou, The Chinese University of Hong Kong

Title: *How Costly is Uncertainty?*

Program Abstract: Optimal stochastic control problem becomes fundamentally different from its deterministic counterpart if the controls taken are going to affect the scale of uncertainty of the system. In this case, the uncertainty basically represents part of the overall cost in the minimizing control problem. This "uncertainty cost" can be explicitly calculated in the linear-quadratic regulator (LQR) problem. As a consequence, the LQR problem turns out to be meaningful in the stochastic case even when large controls are rewarded rather than penalized because the additional uncertainty from using a large control is costly.

INDEX OF PARTICIPANTS

Zane, Omar, University of Bath, ozane@uk.fcnbd.com
Zatezalo, Aleksandar, University of Minnesota, zatezalo@math.umn.edu
Zhang, Qing, University of Georgia,qingz@math.uga.edu
Zhao, Xiaoliang, Columbia University, zhao@stat.columbia.edu
Zhou, X. Y., The Chinese University of Hong Kong, xyzhou@se.cuhk.edu.hk
Zimmer, Peter, University of Kansas, zimmer@math.ukans.edu